VS203B Problem Set: Wave Optics and Superposition

1. The following equations define two mutually coherent light waves that are travelling in a vacuum:

$$E_1 = 3 \cdot \sin\left(12{,}566{,}370 \cdot x - \left(3.77 \times 10^{15}\right) \cdot t + \frac{\pi}{2} \right)$$

$$E_2 = 2 \cdot \sin\left(12{,}566{,}370 \cdot x - \left(3.77 \times 10^{15}\right) \cdot t + \pi\right)$$

where x is distance in meters and t is time in seconds.

a) What is the wavelength for both waves?
b) What is the frequency in cycles per second for both waves?
c) What is the speed of each wave?
d) Which direction are the waves travelling?
e) What is the initial phase in radians for both waves?
f) On a single graph, sketch each wave for a fixed instant in time (set *t=0* and use a distance range of 0 to 1 micron). Use the scale 1 micron = 10 cm for the x-axis and scale of cm for the y-axis.
g) Sketch the sum of the two waves on the same graph.
h) Calculate the intensity of each wave and of the coherent sum of the waves.
i) What would the intensity be if the two waves were in phase?
j) If the two waves were MUTUALLY INCOHERENT, what would the intensity be?

2. Write the wave equation for two waves of the same amplitude that are traveling in a vacuum, have a wavelength of 600 nm, are travelling to the right and are 180 degrees out of phase.

Answers

1. a) 500nm for both b) 6×10^{14} cycles/sec for both c) 3×10^{8} m/s d) to the right e) $\pi/2$ and π h) 9 and 4 i) 25 j) 13
2. $E_1 = A_1 \sin(10{,}471{,}976x - 3.1416 \times 10^{15} t + \pi)$